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Filed : January 2, 2002

REMARKS

In the Final Office Action mailed on April 19, 2004, the Examiner rejected all pending claims, Claims 2-10 and 17-23. Applicants respectfully request full consideration of the remarks contained herein.

Rejections Under 35 U.S.C. § 103(a)

The Examiner has rejected independent Claims 6 and 17 as being obvious in view of Havemann (U.S. Patent No. 6,156,651). In particular, the Examiner has stated that Havemann teaches “depositing a first metal (*tungsten*, 66, see col. 3, lines 19-21) (as claimed in claims 2, 15 and 19) … to partially fill the contact via (see figure 6C), and filling the remainder of the contact via with a second metal (70, *aluminum*, see figure 6E, as claimed in claims 2, and 20).” (emphasis added). The Examiner has also stated that Havemann does not teach depositing the first metal to between about “one-third and two-thirds” of the height of a contact via. The Examiner stated that this limitation is obvious, however, because Havemann teaches “selective deposition fills the via to *less than the height* of the interlevel dielectric, and stop filling prior to reaching the top of the interlevel dielectric layer (see figure 6C, col. 5, lines 39-41, 54-61) would obviously means that filling the contact via with the metal to the height between about one-third and two-thirds (meeting claims 6-7, and 17-18).” (emphasis added).

The Examiner has also rejected dependent Claims 2-5, 7-9 and 18-20 under 35 U.S.C. § 103(a) as being unpatentable over Havemann (U.S. Patent No. 6,156,651) in view of Liu (U.S. Patent No. 6,211,085); dependent Claims 21-23 as being obvious over Havemann in view of Omura (U.S. Patent No. 6,028,362); and dependent Claim 10 as being obvious over Havemann in view of Yu et al. (U.S. Patent No. 6,365,514).

Previously, in the Response to Office Action mailed January 6, 2004, Applicants noted the criticality of the recited deposition levels for the less conductive first metal. In response, the Examiner stated that criticality was not shown because the specification contained no disclosure concerning the critical nature of the claimed range. Applicants also noted in the Response to Office Action mailed January 6, 2004 that the Examiner has not established a *prima facie* case of obviousness because she has not provided a suggestion to make the recited combination of partially filling the via with a less conductive metal and then completing the filling with a more

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conductive metal. In response, the Examiner stated that this limitation is “also obvious/inherent” because “forming the more conductive layer … provide[s] more conductivity.”

Applicants respectfully traverse the rejections.

Initially, Applicants submit that the specification does disclose the criticality of filling a contact via to “between about one-third and two-thirds” of its height with a less conductive metal. As discussed in the previous Response to Office Action, the recited range embodies an advantageous balancing and recognition of several factors, including: the conductivities of the deposited metals, the deposition behavior of the metals relative to their conductivities and the conductivity of the resulting integrated circuit or contact plug. Applicants have found that filling contact vias with relatively high conductivity metals can be difficult with available deposition techniques. On the other hand, filling vias with less conductive metals can be readily accomplished but can adversely affect the conductivity of resulting integrated circuits or contact plugs. Consequently, to balance the deposition behavior of deposited metals with their conductivities and with the conductivities of the resulting structures, Applicants have devised a method in which a less conductive metal is first deposited to raise the floor of the contact via to effectively decrease the aspect ratio of the contact via, thereby facilitating the subsequent deposition of more conductive metals into the vias. By depositing the less conductive metal to a sufficiently high level, while also minimizing the amount of the less conductive metal deposited, the more conductive metal can be deposited with conventional processes to adequately fill the contact via, while still forming a contact structure with good overall conductivity. Applicants have found that these conflicting requirements can most advantageously be reconciled by filling “between about one-thirds and two-thirds” of the contact via height with the less conductive metal. These considerations are disclosed in the Application in, *e.g.*, paragraphs [0006]-[0007] (discussing relatively high and low conductivity metals and their deposition behavior), [0037] (discussing the recited levels of filling with the less conductive metal), and [0054] (discussing the benefits of raising the contact via floor, in view of metal deposition behavior of metals and the conductivities of the metals). Accordingly, Applicants submit that the specification does disclose the criticality of the recited range.

None of the art of record recognize an ability to balance the considerations noted above by the recited process.

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Thus, in view of the criticality of the recited range, Applicants submit that independent Claims 6 and 17, reciting filling a contact via to “about one-third and two-thirds” of its height with a relatively low conductivity metal, are non-obvious in view of the art of record. *In re Woodruff*, 919 F.2d 1575, 16 U.S.P.Q. 2d 1362 (Fed. Cir. 1990) (a claimed range encompassed by a larger prior art range can still be patentable if the claimed range is critical).

Moreover, Applicants note that the art of record does not recognize the relationship between the deposition level of the less conductive metal and the conductivities of the metal, the deposition behavior of the metals and the conductivity of the resulting integrated circuit or contact plug. Applicants submit that the recognition of a relationship and the resolution of a problem not recognized by the art of record is further evidence of the non-obviousness of the Claims 6 and 17. *See, e.g., In re Antonie*, 559 F.2d 618, 195 U.S.P.Q. 6 (C.C.P.A 1977) and *In re Rijckaert*, 9 F.3d 1531, 28 U.S.P.Q.2d 1955 (Fed. Cir. 1993) (finding that claim reciting a particular numerical limitation or relationships were non-obvious due to the recognition of the criticality of that numerical limitation or relationship).

Independent of the criticality of the recited range, Applicants also submit that the Examiner has not established a *prima facie* case of obviousness. Applicants note that independent Claims 6 and 17 each recite depositing a less conductive metal first and then filling the contact via with a more conductive metal. In response to Applicants’ previous remarks that this deposition sequence is not taught or suggested by the art of record, the Examiner has stated that deposition of a more conductive metal is obvious or inherent to provide more conductivity.

This assertion *assumes*, however, that Havemann teaches filling different portions of a via with different metals in the first instance. Moreover, even if Havemann does provide such a teaching, the Examiner has also simply *assumed* that Havemann teaches that the metal in a lower portion of the via should be a less conductive metal. Applicants submit, however, that Havemann does not teach all that has been asserted.

In particular, the Examiner has pointed to Col. 3, lines 19-21 and Figure 6E as teaching tungsten deposition followed by filling with aluminum. Applicants note, however, that Col. 3, lines 19-21 merely states that the “conductors and vias of this invention will generally be either copper, tungsten or aluminum or combinations thereof.” Even assuming that this statement teaches depositing different metals into different portions of a contact via, Havemann does not teach or suggest any specific combinations at all. Havemann’s Figure 6E also does not satisfy

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this deficiency because Havemann clearly states that the metal in the different portions of the via shown in that figure are *both* aluminum. *See* Havemann, Col. 6, lines 40-46. Thus, Havemann does not provide any teaching or suggestion that the aluminum occupying a lower part of the via in Havemann's Figure 6E should be substituted with a less conductive metal, as recited in independent Claims 6 and 17.

In fact, the claims of Havemann make clear that combinations of different pure metals in a via are not even contemplated by that reference. The Examiner has pointed to the words "combinations thereof" in Col. 3, lines 19-21 as supporting the assertion that Havemann teaches depositing tungsten and then aluminum. While the Examiner may interpret a reference broadly, it is well-established that the "prior art must be considered as a whole, including disclosures that teach away from the claims." M.P.E.P. §2141.02. Havemann's claims make clear that the phrase "combinations thereof" actually refers a single material, such as an alloy, and does not refer to different combinations of pure metals arranged over one another. In particular, Claims 1, 4, 12 and 20 recite "depositing a first conductor metal" and that "*said* conductor metal consists of essentially aluminum, tungsten, copper or *combinations thereof*." (emphasis added). Thus, by "combinations thereof," Havemann is referring to the composition of a *single* conductor metal occupying a particular portion of the via, rather than the use of different metals for different portions of the via. As a result, Applicants submit that Havemann does not teach all that has been asserted. As such, Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness with respect to Claims 6 and 17. *See In re Dow Chemical Co.*, 837 F.2d 469, 473, 5 U.S.P.Q.2d 1529, 1531, (Fed. Cir. 1988) ("Both the suggestion [to combine] and the expectation of success, must be founded in the prior art, not in the applicant's disclosure.").

Thus, in constructing the rejections, the Examiner has provided *no guidance from the prior art* for her choices for: (1) selection of a lower conductivity material for the lower portion of the via; (2) selection of a higher conductivity material for the upper portion of the via; or (3) selection to stop the first deposition at between about one-third and two-thirds of the via height. The Examiner's ostensible suggestion (to improve conductivity) cannot explain choices (1) nor (3).

Rather, it appears that the Examiner has pointed to individual teachings in the art of record and reconstructed the invention using the claims as a template. It is well established, however, that reconstruction of the invention based upon hindsight gained from the claims is

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impermissible; instead, the “examiner must show reasons that the skilled artisan, confronted with the same problems as the inventor and with no knowledge of the claimed invention, would select the elements from the cited prior art references for combination in the manner claimed.” *In re Rouffet*, 47 U.S.P.Q.2d 1453, 1457-58 (Fed. Cir. 1998); *see also In re Gorman*, 18 U.S.P.Q.2d 1885, 1888 (Fed. Cir. 1991) (“It is impermissible, however, simply to engage in a hindsight reconstruction of the claimed invention, using the applicant’s structure as a template and selecting elements from references to fill the gaps.”). In this case, the Examiner has not provided any teaching or suggestion from the prior art to deposit a less conductive metal before a more conductive metal, nor does the prior art teach or suggest the particularly advantageous deposition levels recited in independent Claims 6 and 17.

Accordingly, Applicants respectfully submit that the pending claims are allowable over the art of record. Applicants have not specifically addressed the rejections of dependent claims as being moot in view of the remarks herein, nor have Applicants specifically addressed the asserted teachings of the art of record apart from Havemann. However, Applicants expressly do not acquiesce in the Examiner’s findings not addressed herein. Moreover, Applicants submit that the dependent claims recite further novel and non-obvious features of particular utility.

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CONCLUSIONS

In view of the foregoing remarks, Applicants submit that the application is in condition for allowance and request the same. If some issue remains that the Examiner feels may be addressed by Examiner's amendment, the Examiner is invited to call the undersigned for authorization.

Respectfully submitted,

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Dated: June 18, 2004

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